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DESCRIPTION OF MALE *OSTROCERCA* RICKER (PLECOPTERA: NEMOURIDAE) USING THE SCANNING ELECTRON MICROSCOPE

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Abstract.—Scanning electron micrographs of the male terminalia are given for all six species of the stonefly genus *Ostrocerca* Ricker: *O. albidipennis* (Walker), *O. complexa* (Claassen), *O. dimicki* (Frison), *O. foersteri* (Ricker), *O. prolongata* (Claassen), and *O. truncata* (Claassen). Structures of the male genitalia previously not illustrated are described. Distribution records for each species are also reported.

Key Words: Stonefly, Plecoptera, Nemouridae, *Ostrocerca*, scanning electron micrographs

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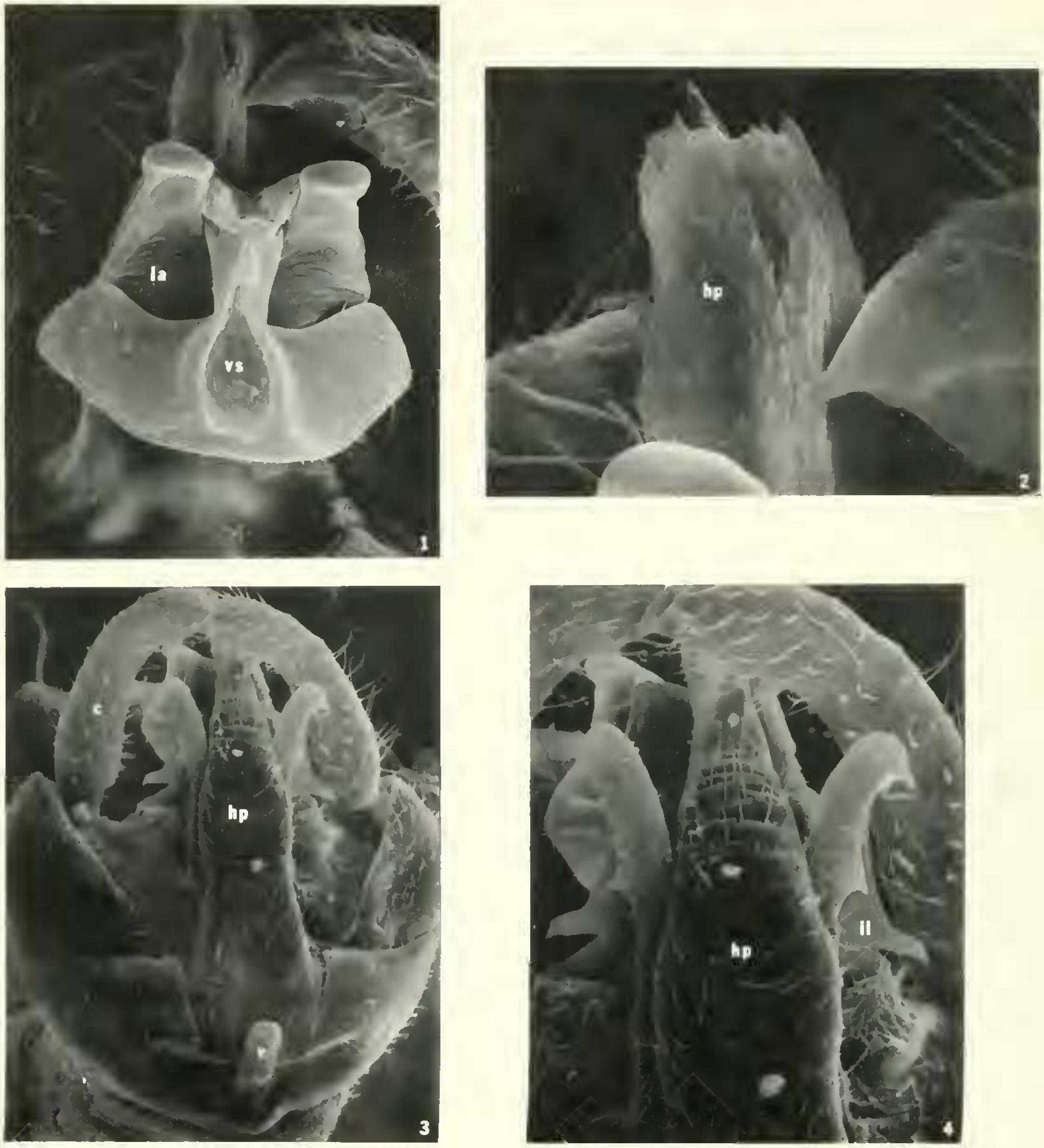
Scanning electron microscopy (SEM) has been used recently to elucidate fine structures of the male genitalia of stoneflies (Kondratieff and Kirchner 1984, Nelson and Baumann 1987). Newly recognized structures have been used in making determinations and preparing relationships.

The Nearctic genus *Ostrocerca* Ricker contains six species and is known for its small size (4–8 mm) and complex male genitalia (Ricker 1952). This genus occurs in eastern (four species) and northwestern (two species) North America (Stark et al. 1986). Nymphs usually inhabit crenon habitats, and adults are rare in collections, but can be collected by sweeping or beating.

Keys to males and females are provided by Ricker (1952) in his review of the genus and an updated key to females is given in his 1965 paper. Hitchcock's (1974) study enables the separation of the four eastern species. Baumann's (1975) generic description is based primarily on *O. truncata* Claassen. Our previous studies of specimens from Virginia (Kondratieff and Kirchner 1987) and West Virginia (Tarter and Kirchner 1980) showed that it is difficult to see the arrangement of structures of the complex epiproct with standard light microscopes. Using published illustrations, especially of the eastern species (Claassen 1923, Hitchcock 1974), it often appeared that additional taxa could be involved. Therefore, we used SEM to study the male genitalia of *Ostrocerca*. The higher magnification and greater depth of field in SEM made it possible to illustrate structures not previously recognized.

METHODS AND MATERIALS

Specimens were prepared for study by removing them from 70–80% ethanol, submersing them in liquid Freon 12 at −154°C for several minutes, and then placing them into stored liquid nitrogen (−110°C to −80°C) and into a Balzers 301 Freeze-Fracture Unit at 10^{6} mv. Specimens were then mounted and sputter coated with gold in a Hummer V Sputter Coater. Specimens were



Figs. 1–4. *Ostrocerca albidipennis.* 1, Epiproct, dorsal view, 312×. 2, Hypoproct, apex, 845×. 3, Terminalia, ventral view, 120×. 4, Terminalia, ventral view, 241×. Terms: hp, hypoproct; vs, ventral sclerite; la, lateral arms; il, inner lobe; c, cerci; v, vesicle.

viewed using a Phillips 505 SEM at 30,000 accelerating voltage.

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Morphological terms of the following descriptions follow Baumann (1975). Baumann (1975) provides excellent illustrations of the male terminalia of *O. truncata*, clearly indicating the orientation of the structures of the male epiproct. Abbreviations used on the SEM photographs include hp, hypoproct; ds, dorsal sclerite; vs, ventral sclerite; la, lateral arms; ol, outer lobe; ml, middle lobe; il, inner lobe; c, cerci; and v, vesicle.

Ostrocerca albidipennis (Walker)

Nemoura albidipennis Walker, 1852: 191. Type locality: Nova Scotia, Canada.

Nemoura serrata Claassen, 1923: 289. Type locality, Bar Harbor, (Hancock Co.) Maine; Ricker, 1952: 39 (syn.).

Ostrocerca albidipennis, Illies, 1966: 217.

The distinctive epiproct has a hammerhead shaped ventral sclerite, which is overlapped by the lateral arms of the dorsal sclerite (Fig. 1). The hypoproct is long and slender, and terminates in a complex serrate structure (Fig. 2). The paraprocts have inner lobes that are hooked medially and beaklike apically (Figs. 3 and 4). The figures presented by Claassen (1923) as *N. serrata* and by Hitchcock (1974) do not accurately depict these complicated structures.

The female is accurately illustrated by Hitchcock (1974) and by Ricker (1965).

Material examined.—Holotype M (*N. serrata*), Bar Harbor, Maine, 8 VI 1921, C. W. Johnson (Cornell #1199). Paratype: same data as holotype, 1 M (Cornell #1199).

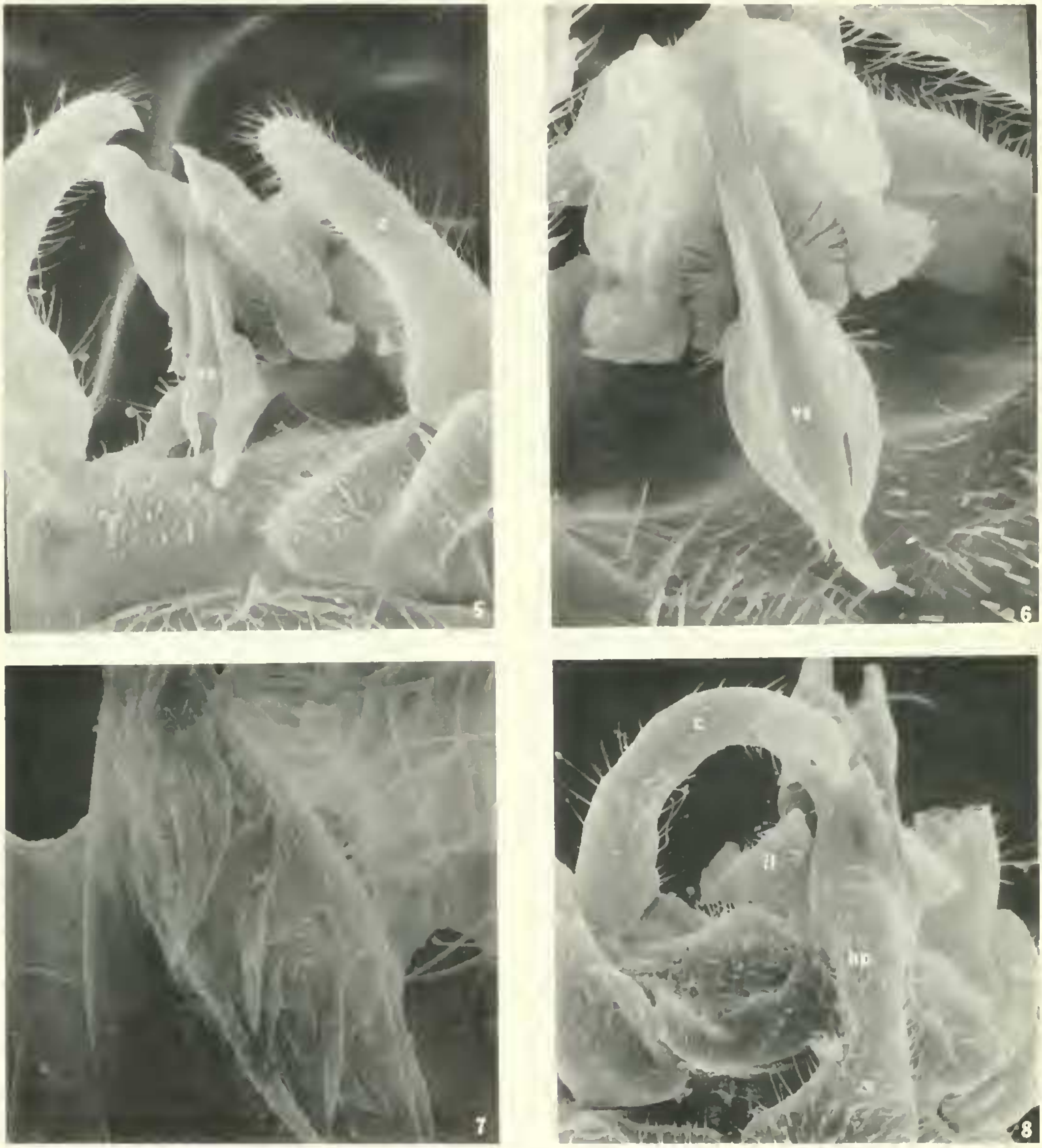
Other specimens: CANADA: Ontario, Algonquin Park, Costello Lake, 26 V 1938, W. M. Sprules, 1 M (INHS); same locality, 29 V 1939, 2 M (INHS); same locality, 26 V 1941, 1 M (INHS); Maynooth, Spring Creeks, 22 VI 1953, J. F. McAlpine, 2 M (CNC); Petawawa, Meridian Road, Forest Station, 28 V 1959, J. R. Vockeroth, 1 M, 1 F (CNC). Quebec, Harrington Lake, Gatineau Park, 27 V 1954, H. J. Huckel, 1 M, 6 F (CNC); Harrington Lake, 30 V 1954, E. E. Sterns, 3 M, 3 F (CNC); Wakefield, Lindsay's Creek, 31 V 1930, J. McDunnough, 1 M (CNC). CONNECTICUT: Naugatuck State Forest, Beacon Falls, 17 V 1961, S. W. Hitchcock, 5 M, 1 N (USNM). MAINE: on dropnet, (no locality) 4–14 VI 1970, D. E. Leonard, 4 M (USNM). MASSACHUSETTS: Whately, 18 V 1939, W. B. Nutting, 1 M, 4 F (USNM). NEW HAMPSHIRE: Warren, 21 VI 1941, T. H. Frison & H. H. Ross, 1 M (INHS). TENNESSEE: Cumberland Co., small stream, 2 mi. N of Adams Bridge, Obed River, Rt. 298, 13 V 1988, R. W. Baumann, C. R. Nelson, RFK & BCK, 1 M, 2 F (CSU). VERMONT: Mt. Hay Stack, 2400′, 28 V 1938, W. B. Nutting, 1 M (USNM). VIRGINIA: Giles Co., Mountain Lake, 2 VI 1962, J. R. Vockeroth, 2 F (CNC); Grayson Co., springs into Lewis Fork, Co. Rt. 603, 4 mi. W of Troutdale, 9–30 VI 1981, 16 M, 5 F, 3 N, RFK & BCK (RFK), 11 M, 9 F, 6 N BCK (VPI); Smyth Co., springs to Big Laurel Creek, Trail 166, Jefferson National Forest, 30 VI 1981, RFK & BCK, 2 F (RFK); Washington Co., spring to Brumley Creek, Clinch Mountain at Low Gap, Co. Rt. 690, 3600′, 23 VI 1981, RFK & BCK, 9 M, 6 F (RFK); Wise Co., Phillips Creek Rec. Area, N Fork Pound Reservoir, off Co. Rt. 671, 29 IV 1987, RFK & BCK, 1 M (BCK). WEST VIRGINIA: Pocahontas Co., Island Lick Run of Greenbriar R., Watoga State Park, Rt. 27, 16 VI 1981, RFK, 1 M (RFK); springs to Hills Creek, Rt. 39, Monongahela National Forest, 16 VI 1981, RFK, 1 M (RFK).

Ostrocerca complexa (Claassen)

Nemoura complexa Claassen, 1937: 43. Type locality: Artists Brook, Essex County, New York.

Ostrocerca complexa, Illies, 1966: 217.

The elaborate epiproct (Figs. 5, 6) of this species has never been completely illustrat-



Figs. 5–8. *Ostrocerca complexa.* 5, Terminalia, dorsolateral view, 194 ×. 6, Epiproct, dorsal view, 212 ×. 7, Basal cushion of the dorsal sclerite, 965 ×. 8, Terminalia, ventral view, 163 ×. Terms: hp, hypoproct; vs, ventral sclerite; il, inner lobe; c, cerci; v, vesicle.

ed (see Claassen's 1937, Fig. 2 and Hitchcock's 1974, Fig. 107). The ventral sclerite is fork-like with a lower process that is elongate and apically recurved. The membranous basal cushion of the dorsal sclerite has five to six cuticular spine-like projections proximally and four to five distally (Fig. 7). These projections often appear membranous in SEM photomicrographs. The inner lobes of each paraproct are triangularly produced. The hypoproct is bifurcate apically (Fig. 8). The cerci are notched (Fig. 8).

The terminalia of the female are illustrated by Hitchcock (1974) and Ricker (1952, 1965).

Material examined.—Holotype M: Artists Brook, Essex Co., New York, 11 VI 1933, C. R. Crosby & H. Deitrich (Cornell #1692). Paratypes: same locality as holotype, 28 June 1923, P. W. Claassen, 1 M (Cornell #1692).

Other specimens: VERMONT: brooklet top of Brandon Gap, 2170′, 25 VI 1966, S. W. Hitchcock, 1 M (USNM). VIRGINIA: Nelson Co., tributary to South Fork Tye River, Montebello Fish Culture Station, jct. Rt. 690 & Rt. 56, 3 V 1980, BCK, 1 M, 2 F (VPI). WEST VIRGINIA: Pendleton Co., Spruce Knob, 4 mi. below summit, 16 V 1963, Field & O. S. Flint, 1 M (USNM); Pocahontas Co., springs to Hills Creek, 15 mi. E Richwood, Hills Creek Scenic Area, Rt. 39, Monongahela National Forest, 16 V 1981, RFK, 14 M, 6 F (RFK), same locality 15 V 1986, RFK & BCK, 2 M, 1 F (BCK); Tea Creek, Tea Creek Campground, Monongahela National Forest, 21 V 1978, RFK & R. M. Meyer, 1 M (RFK).

Ostrocerca dimicki (Frison)

Nemoura dimicki Frison, 1936: 256. Type locality: Corvallis, Oregon.
Ostrocerca dimicki, Illies, 1966: 217.

This species is easily recognized by the hook-shaped ventral sclerite with erect setose processes (Figs. 9, 10, 11). The inner lobes of the hypoproct are robust and elongate, apically acute, and setose (Fig. 12). The hypoproct is broadly truncate apically and bears a medial sclerotized slender process (Fig. 12).

The female terminalia is illustrated by Ricker (1965).

Material examined.—Holotype M, Corvallis, Oregon, branch Dixon Creek, emerged 28 II 1935, R. W. Prentiss (INHS). Paratypes: Corvallis, drainage stream, 16 III 1934, E. E. Ball, 5 M (USNM); same data, 2 F (INHS); Corvallis, Brooklane Creek, 28 II 1935, R. W. Prentiss, 1 M (USNM).

Other specimens: CANADA: British Columbia, 30 V–18 VI 1955, R. Coyles, 1 M (CNC). OREGON: Washington Co., North Plains, 7 IV 1968, K. Goeden, 1 M, 2 F (USNM).

Ostrocerca foersteri (Ricker)

Nemoura foersteri Ricker, 1943: 70. Type locality: Reservoir Creek, Cultus Lake, British Columbia.
Ostrocerca foersteri, Illies, 1966: 218.

The epiproct is simple (Figs. 13, 14), with the ventral sclerite knob-shaped and surrounded by the hook-like lateral lobes of the dorsal sclerite. The inner lobe of the paraprocts is slender and slightly hook-like (Fig. 14).

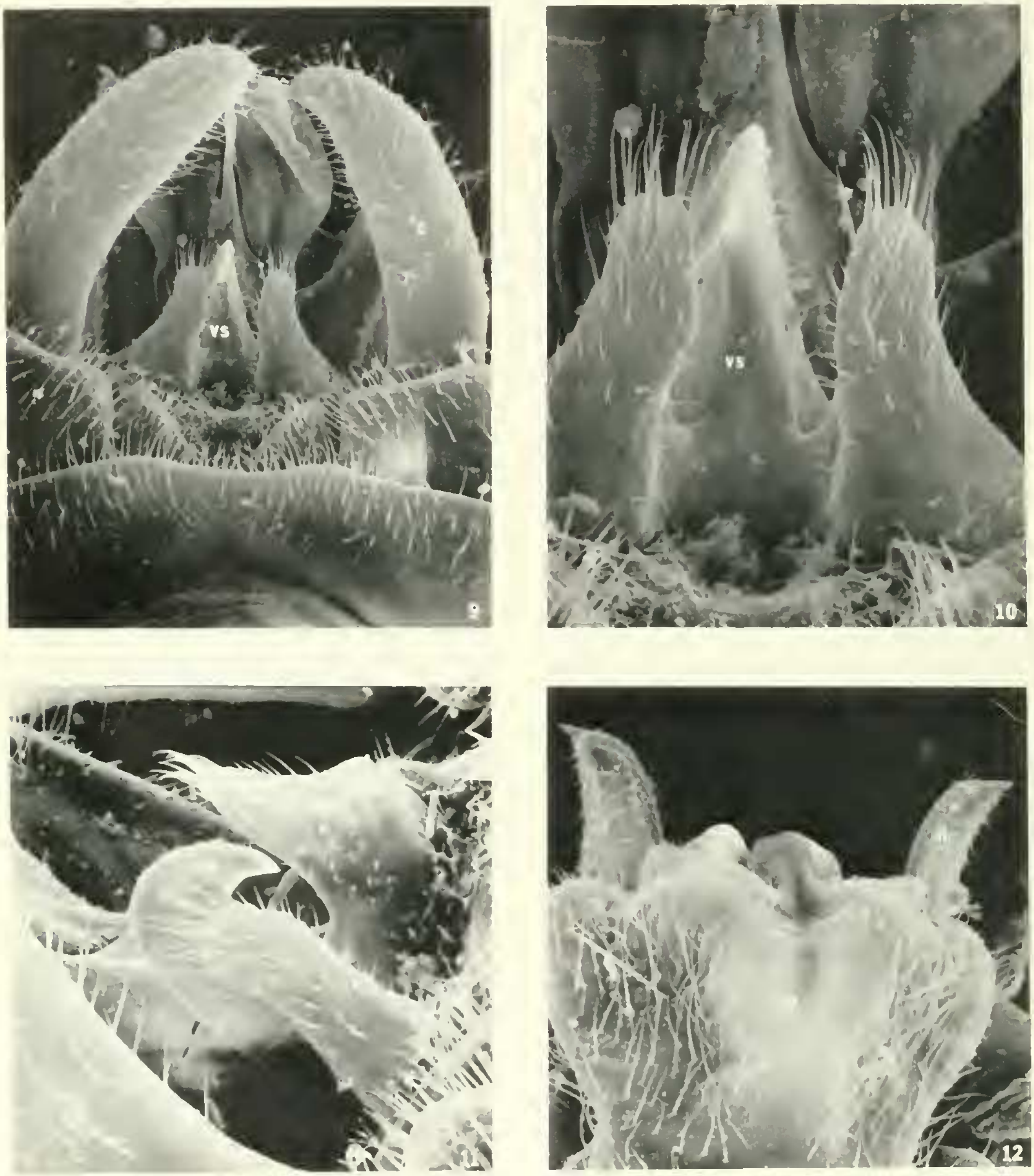
Material examined.—Paratype: Benton Co., Oregon, Rock Creek, Corvallis, 9 IV 1935, K. Grey, 1 M (INHS).

Other specimens: CANADA: British Columbia, Qualicum Bay, 15 V 1955, G. E. Shewell, 1 M, 11 F (CNC). CALIFORNIA: Humboldt Co., Willow Cr., Hwy 299, below Berry summit, 24 IV 1987, R. W. Baumann, C. R. Nelson, B. P. Stark & S. A. Wells, 6 M, 2 F (BYU). OREGON: Clatsop, Vic., Gronnel Road, ca. 2 mi. E Elsie, 1 IV 1967, S. G. Jewett, Jr., 7 M, 3 F (INHS); Douglas Co., 10 mi. E Gardner, 23 IV 1964, Vertrees & Schuh, 3 M, 13 F (USNM); Multnomah Co., Johnson Cr., trib. near SE 82 Ave., 8 III 1987, G. R. Fiala, 7 M (BYU).

Ostrocerca prolongata (Claassen)

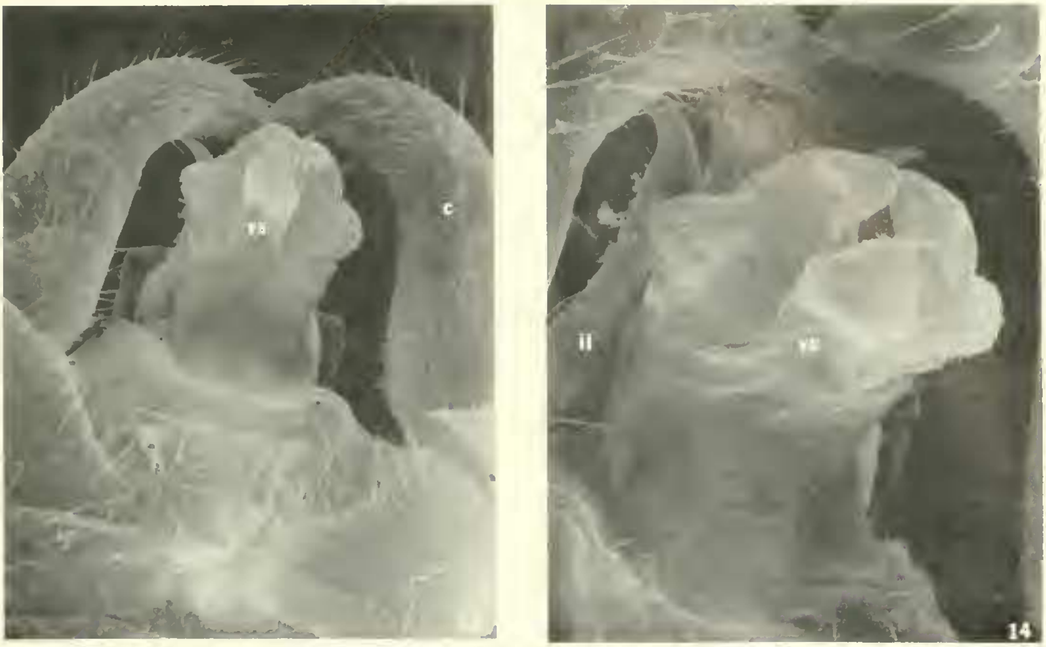
Nemoura prolongata Claassen, 1923: 289. Type locality: Bretton Woods, New Hampshire.
Ostrocerca prolongata, Illies, 1966: 218.

The complex ventral sclerite is characterized by two recurved erect processes and distally terminating in an elongate process (Figs. 15–18). The dorsal sclerite terminates into diverging lobes (Fig. 17). The inner lobes of the paraprocts are long and apically hooked (Figs. 19–21). The cerci are long and curved.



Figs. 9–12. *Ostrocerca dimicki.* 9. Terminalia, dorsal view, 163×. 10. Epiproct, dorsal view, 462×. 11, Ventral sclerite, lateral view, 356×. 12, Terminalia, ventral view, 120×. Terms: hp, hypoproct; vs, ventral sclerite; c, cerci; v, vesicle.

The allotype female is badly damaged and the terminalia are missing. As Hitchcock (1974) points out, the female illustrated by Claassen (1923) may be misidentified. The subgenital plate (as illustrated), and venation is very similar to the sympatric *Soyedina washingtoni* (Claassen). Females found in collections with male *O. prolongata* ex-



Figs. 13–14. *Ostrocerca foersteri.* 13, Terminalia, dorsal view, 163×. 14, Terminalia, dorsal view, 462×. Terms: vs, ventral sclerite; il, inner lobe; c, cerci.

amined during this study were similar to females of *O. complexa* and *O. albidipennis.* And, because *Ostrocerca prolongata* was usually collected with the other two species, made positive association impossible. This species appears to be rare throughout its range.

Material examined.—Holotype M: Bretton Woods, New Hampshire. C. W. Johnson, 26 VI 1913 (MCZ). Paratype: Orono, Maine, 1 M (Cornell #1200). Allotype F: Orono, Maine (Cornell #1200).

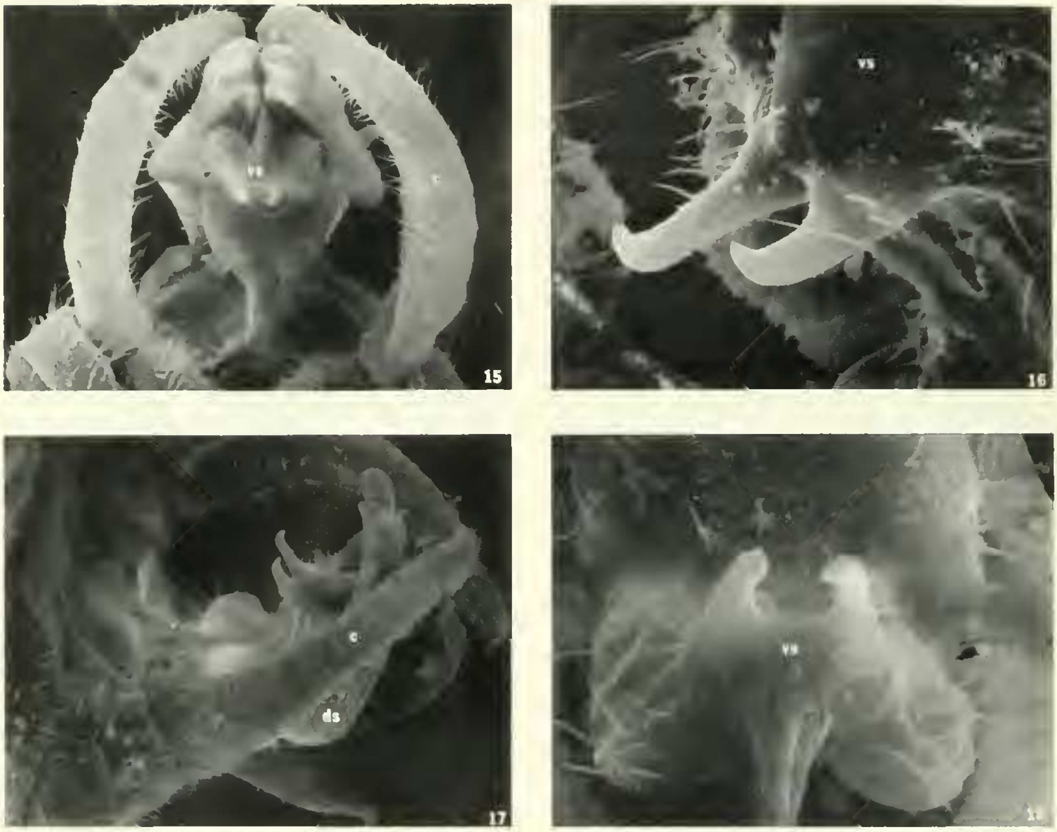
Other specimens: NEW HAMPSHIRE: Huntington Ravine, 4000′, 15 VIII 1935, C. P. Alexander, 1 M (USNM). NEW YORK: Heart Lake, Adirondacks, 2100′, 10 VII 1938, C. P. Alexander, 1 M (USNM). MAINE: on dropnet, no locality, 4–14 VI 1970, D. E. Leonard, 5 M (USNM). VIRGINIA: Nelson Co., small tributary of South Fork Tye River, Rt., 687, 3 V 1980, BCK, 2 M (VPI). WEST VIRGINIA: Tucker Co., Red Creek at Laneville, 26, 27 May 1973, O. S. Flint, 2 M (USNM).

Ostrocerca truncata (Claassen)

Nemoura truncata Claassen, 1923: 290. Type locality, Walden, Massachusetts.
Ostrocerca truncata, Illies, 1966: 218.

This species is easily recognized by the bell-shaped ventral sclerite of the epiproct and thickened, short cerci (Figs. 22 and 23). The slender diverging inner lobes of the paraprocts are also distinctive (Figs. 24-25). The middorsal groove terminating in two sharp projections was not illustrated by Claassen (1923) (same illustrations used by Needham and Claassen, 1925) and Hitchcock (1974). Baumann (1975) illustration (Fig. 76) does not indicate the extent of these projections.

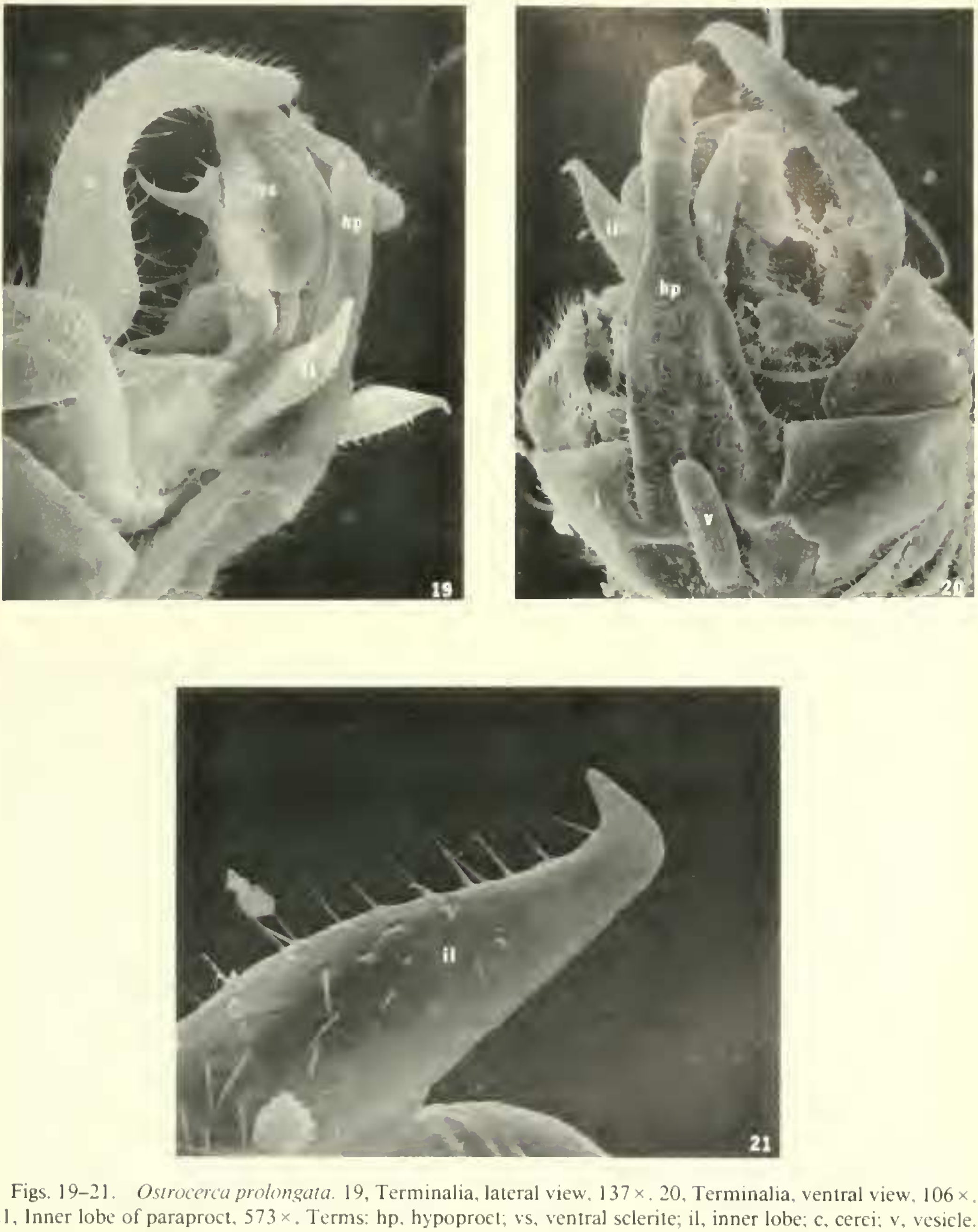
The female has been illustrated by Baumann (1975), Hitchcock (1974) and Ricker



Figs. 15–18. *Ostrocerca prolongata.* 15, Terminalia, dorsal view, 170×. 16, Process of ventral sclerite, 655×. 17, Terminalia, lateral view, 156×. 18, Ventral sclerite, bifurcate process, 356×. Terms: ds, dorsal sclerite; vs, ventral sclerite; c, cerci.

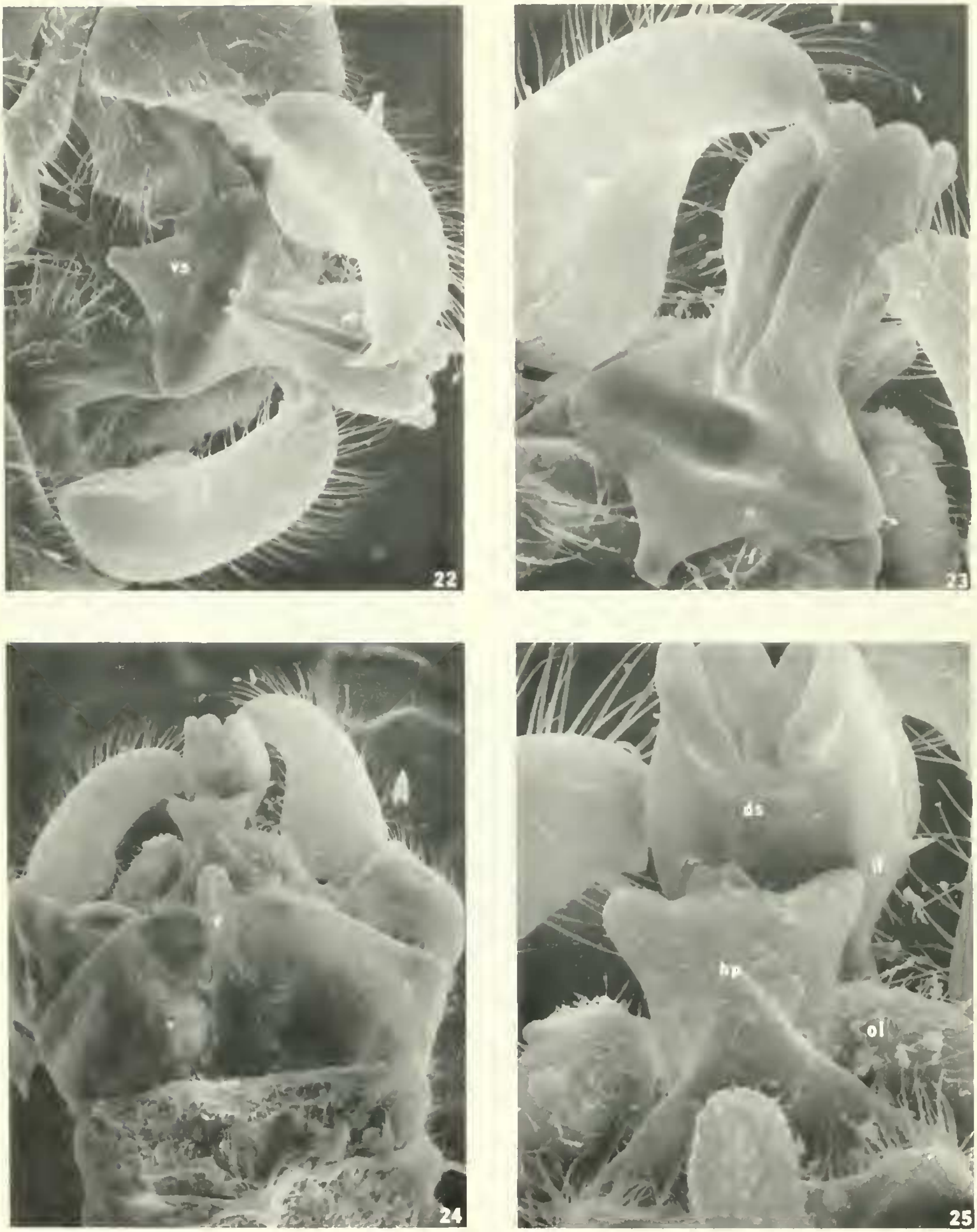
(1965). This species was once considered the rarest of the *Ostrocerca.* But, we found it to be common and widespread. The Alabama collection represents the southernmost extension of its range and is a new state record. The holotype of *Nemoura truncata* could not be located at the Museum of Comparative Zoology (C. Vogt, personal communication).

Material examined.—ALABAMA: DeKalb Co., spring seep, DeSoto State Park, River Trail, cabins 8 & 9, 17 V 1988, RFK & BCK, 1 F (BCK). CONNECTICUT: Beacon Falls, Naugatuck St. Forest, 17 VI 1961, S. W. Hitchcock, 1 M (USNM); Portland, 20 VI 1963, S. W. Hitchcock, 1 M (USNM); Newtown, 10 V 1962, S. W. Hitchcock, 3 M, 2 F (USNM). KENTUCKY: Bell Co., Stream at Pinnacle Rd. entrance, Cumberland Gap National Park, 10 IV 1971, R. A. Haick & C. R. Haick, 4 M, 8 N (USNM); Lawrence Co., Bridge Hollow of Hood Cr., 1.5 mi. S of Blaine Rt. 201, 20 IV 1984, RFK, 10 M (RFK). MASSACHUSETTS: Whately, Whately Glen, 18 V 1938, J. F. Hanson, 1 M (USNM); OHIO: Athens Co., Canaan Township, 25 IV 1941, J. Walker, 1 M (INHS). PENNSYLVANIA: York Co., spring seepage, Davidsburg, 5 mi. NW Woodland, 20 V 1962, P. J. Spangler, 12 M, 22 F, 12 N (USNM). VIRGINIA: Dickenson Co., spring seep into Hunts Creek,



Figs. 19–21. *Ostrocerca prolongata.* 19, Terminalia, lateral view, 137×. 20, Terminalia, ventral view, 106×. 21, Inner lobe of paraproct, 573×. Terms: hp, hypoproct; vs, ventral sclerite; il, inner lobe; c, cerci; v, vesicle.

Rt. 80, Breaks Interstate Park, 29 April 1987, RFK, BCK, 6 F (BCK); Tazwell Co., Station Springs Cr., Burkes Garden 3840′, off Rt. 666, 20 V 1982, RFK & BCK, 48 M, 14 F (RFK); Washington Co., spring to Brumley Cr., Clinch Mtn. at Low Gap, 3600′, Rt. 690, 23 V 1981, RFK & BCK, 15 M, 8 F (RFK); Wythe Co., Stony Fk. of



Figs. 22–25. *Ostrocerca truncata*. 22, Terminalia, dorsal view, 178 ×. 23, Epiproct, dorsal view, 263 ×. 24, Terminalia, ventral view, 120 ×. 25, Terminalia, ventral view, 356 ×. Terms: hp, hypoproct; ds, dorsal sclerite; vs, ventral sclerite; il, inner lobe; ol, outer lobe; c, cerci; v, vesicle.

Reed Cr., Dark Horse Hollow Rec. Area, Jefferson Nat. For., 29 IV 1978, RFK, 1 M (RFK). WEST VIRGINIA: Cabell Co., Lusher Hollow of Mud River, near Barboursville, US-60, 29-IV-1979, RFK, 4 M, 2 F (RFK); same locality 28 IV 1978, 4 M, 1 N (RFK); Greenbrier Co., Coats Run, Rt. 39, 26 IV 1987, RFK, BCK, 2 M (RFK); Logan Co., Trace Fork of Copperas Mine Fork, Holden, 15 IV 1973, RFK, 1 F (RFK); Pendleton Co., Spruce Knob, 4 mi. below summit, 16 V 1963, W D. Field & O. S. Flint, 1 M, 1 F (USNM); Pocahontas Co., Hills Cr., 15 mi. E of Richwood, Rt. 39, Monongahela NF, 20 V 1978, RFK, 2 F (RFK); East Fork Greenbrier River, Forest Rd., off Rt. 28, 26 IV 1987, RFK & BCK, 2 M (BCK); Tucker Co., Red Creek near Laneville, 26, 27 VI 1973, O. S. Flint, 1 M, 3 F (USNM).

Discussion

Examination of the males of *Ostrocerca* with SEM indicated that no taxonomic changes were necessary. However, the higher magnification and greater depth of field allowed for the first time a complete study of the male terminalia of all six species. The SEM micrographs elucidated structures of the epiproct previously not illustrated. For example, the distinctive fork-like ventral sclerite of *O. complexa* easily distinguishes this species; the serrate apex of the hypoproct is only found in *O. albidipennis*; and the ventral sclerite terminating in an elongate process is characteristic of *O. prolongata*. Consulting these micrographs will make it easier to identify male specimens using a dissecting microscope by confirming characters not illustrated or mentioned in original descriptions or redescriptions.

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